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STRUCTURE OF 0.5WT%-BORON ADDED HIGH-CR CAST IRON

The properties of high-chromium cast irons (HHCIs) can be significantly improved by boron addition. It was reported that the microalloying of 17 wt% Cr cast iron with 195 ppm of boron promoted the precipitation of secondary carbides and leads to the improvement of their erosion-corrosion resistance. The addition of ~0.55 wt.% boron to Ni-Hard-4 cast iron (ASTM A532) and directionally solidified HHCI can positively contribute to the hardness and wear resistance of these materials. Boron affects HHCIs by stabilizing the carbide phase, increasing the carbide volume fraction, and refining primary M_7C_3 carbides. However, the influences of boron on the structural properties and phase elemental composition of high-Cr-Mo cast iron are still not studied elaborately. Hence, the present work was dedicated to exploring the microstructural characteristics and phase elemental distribution of 3.6C-15Cr-2Mo-0.5B cast iron.

After 0.50 wt% boron addition, the 3.6 wt% C-15 wt% Cr-2 wt% Mo cast iron acquired a hypereutectic structure consisting of primary carbides and carbide eutectics with a carbide total volume fraction of 51.8 vol%. The XRD study revealed that the as-cast alloy consisted of α-Fe, austenite, and carbides. The identification of carbide phases was difficult due to the proximity of the PDF data for different phases, such as Cr_7C_3 (M_7C_3), Fe_3C (M_3C), $Cr_{23}C_6$, Cr_3C_2, Mo_2C (M_2C), and Mo_6C (M_6C). Only one weak peak (422) at $2\theta = 56.9^{\circ}$ corresponds to M_7C_3 carbides. No peaks of boride were detected in the XRD pattern. Austenite in amount of 32 vol.% was detected in the as-cast matrix. The carbon content in austenite was calculated as 1.38 wt%. Eutectics were (a) M_7C_3-based rosette-shaped eutectic, (b) M_3C-based coarse-net-shaped eutectic, and (c) M_3C-based Ledeburite-shaped eutectic. The as-cast matrix consisted of austenite (32 vol.%) and α-Fe (martensite and pearlite). A small amount of micron-sized areas containing 67.5 wt% Mo and 4.6 wt% Si (presumed as M_6C carbides) was also observed.

Chromium and molybdenum with an opposite phase distribution characteristic were unevenly partitioned in Cr-rich/Mo-depleted areas in the matrix and carbide phases. Austenite areas were Cr-rich/Mo-depleted, martensitic areas were associated with the Cr-depleted matrix next to carbides, and pearlite areas were Cr-rich/Si-rich/Mo-depleted. The uneven distribution of Cr and Mo formed duplex carbides (both primary and eutectic) consisting of a Cr-rich/Mo-depleted core (M_7C_3 carbides) and a Cr-depleted/Mo-rich shell (M_3C carbides). Duplex carbides appeared from the peritectic reaction between M_7C_3 carbides with the Cr-

depleted melt (Fig. 1). Further, the shell surface acted as an interface for the solidification of binary "A + M_3C" eutectic.

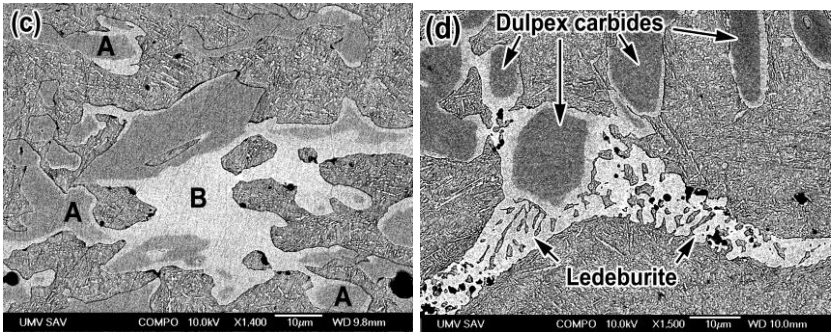

Figure 1 – Duplex carbides in B-containing high-Cr cast iron [1]

The holding of the cast iron at 950°C for two hours led to the precipitation of fine secondary carbides (Fig. 2) in the matrix followed by the martensitic transformation of destabilized austenite upon oil-cooling. This treatment drastically increased the hardness from 672 HV (as-cast) to 1038 HV.

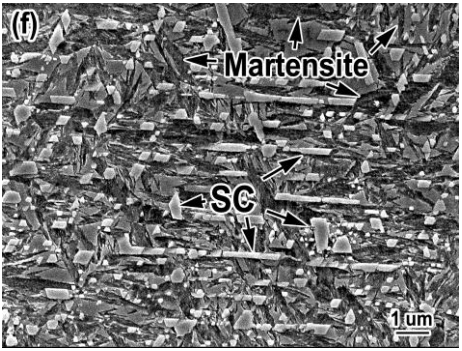

Figure 2 – Secondary carbides in B-containing high-Cr cast iron [1]

СПИСОК ВИКОРИСТАНОЇ ЛІТЕРАТУРИ

1. Efremenko V.G., Wu K. M., Shimizu K., Petryshynets I., Efremenko B.V., Halfa H., Chabak Yu.G., Malyshevskyi A.A., Zurnadzy V.I. Charakterisierung der Mikrostruktur und Elementzusammensetzung von Gusseisen mit 15 Gew.-% Cr und 2 Gew.-% Mo mit Bor-Zusatz (Characterization of Microstructure and Phase Elemental Composition of 15 wt.% Cr – 2 wt.% Mo Cast Iron with Boron Addition). *Practical Metallography*. 2020. Volume 57. Issue 10. P. 714-742.